

(7) The establishment of a solar physics observatory for the systematic examination and study of the changes in progress in the sun and their correlation with the larger features of Indian meteorology and the transfer of the Magnetic Observatory at Colaba and the Astronomical Observatory at Madras from provincial to imperial control.

The present work of the department and the chief directions in which extension is desirable may be classified under the following heads:

(1) The collection of accurate meteorological data from a sufficient number of representative stations to give the chief facts of the climatology of India and to furnish data for the issue of the various reports and warnings of the department.

(2) Special meteorological investigations.

(3) Seasonal forecasts.

(4) Marine meteorology.

(5) Daily weather reports.

(6) Issue of flood and storm warnings.

The work under the second head admits of very large and special development. Little or nothing is known of the depth of the seasonal atmospheric currents in India. Kite or balloon investigations are hence greatly to be desired. Similarly the relations of sun spots and terrestrial magnetism to Indian meteorology are deserving of a full and careful investigation, for which there is probably sufficient accurate material to enable these questions to be usefully discussed.

A reference to my opinion given in 1878 expresses fully the directions in which I believe now, as then, extension of observation and comparison is necessary in order to increase the value of the seasonal forecasts. Slight extensions have been slowly and tentatively made during recent years, but if further improvement be desired it will be necessary to collect and compare data from a much wider area than has hitherto been possible with the limited available means.

The opinion given in 1878 by Mr. Eliot had reference to "the coordination of the meteorology of India with that of the various countries adjoining the Indian Ocean, and also with that of Europe," for the purpose of studying the two great monsoon currents of India and their possible relation to the variations in the annual rainfall in India, as well as the relation between these variations and the solar radiation and the evaporation over the area which forms the source of the rains of south Asia.

This illustrates the broad policy upon which the Indian Meteorological Office has been conducted during the administration of Mr. Eliot. It is the same as the policy that has led to the expansion of our own Weather Bureau to include reports from the Atlantic and Pacific oceans, Canada, Mexico, Central America, and the West Indies, and from such expansions meteorology is deriving decided benefit.—H. H. K.

#### PAMPHLETS RELATIVE TO WETTERSCHIESSEN.

No. 1. G. Suschnig. Bericht über den Verlauf des dritten internat. Wetterschiess Congresses zu Lyon am 15, 16 und 17 November, 1901.

No. 2. G. Suschnig. Referat über die Erfolge und Beobachtungen beim Wetterschiessen in Oesterreich erstattet dem III. internationalen Wetterschiess Congress in Lyon am 15 November, 1901.

No. 3. Rudolf Szutsek. Bericht über das Wetterschiessen im Landes-Schiess-Rayon zu Windisch-Feistritz, in den Jahren 1900, 1901. Bearbeitet von Rudolf Szutsek, k. u. k. Oberstlieutenant I. R. Leiter des obigen Landes-Schiess-Rayons. Graz, 1901.

This pamphlet of 16 pages and 2 charts contains a most satisfactory detailed account of the methods and operations at the headquarters of the hail shooting system. It contains the results of careful observations of the hailstorms and of the effect of the shooting. The charts show the irregularity in the distribution of hail from the ordinary storms as well as the irregularities in the movements of these storms, of which there were 8 in 1900, and 7 in 1901. We should say that just as Dyrenforth's explosions of dynamite were observed to be followed by rain, or accompanied by rain, or preceded by rain, according as the observers happened to be in front of, or under, or in the rear of a passing shower, thereby demonstra-

ting its utter inefficiency, so with the cannonading and the hail at Windisch-Feistritz. However, on this latter point Lieutenant Szutsek, on page 14, says:

Although no certain conclusions can be drawn from the previous observations because we have too little material on hand, still the results give some ground for the hope that the question whether hail shooting is efficacious, whose solution the whole world awaits with anxiety, can be answered in the near future.

No. 4. G. Suschnig. Das Wetterschiessen. Graz. 1901.

This is a very interesting general history of the subject from 1750 to May, 1901. It gives an excellent bibliography of the subject and is apparently prepared for distribution at the Congress at Lyons.—C. A.

#### THE THIRD INTERNATIONAL CONGRESS ON HAIL SHOOTING.

On a following page we publish a translation of the whole of the report offered to the Third International Congress at Lyons in November last, by Prof. J. R. Plumandon, Director of the Meteorological Observatory on the Puy-de-Dôme in southern France. The extent to which cannonading against hail has spread through Italy, Austria, and France is well shown by the reports presented at the Congress at Lyons. The general report of the proceedings of the congress has been prepared by G. Suschnig, the indefatigable agent of the iron manufacturing firm of Carl Greinitz and Nephews at Gratz, Austria. According to this publication reports were received at the congress from the following persons:

1. Professor Battanchon on the general history of the subject of weather shooting.

2. Guinand, on the results in France, during 1901, where 39 operators with 834 cannon protected 22,900 hectares. He reported perfect success in every case; on this Suschnig remarks that he is altogether too optimistic, and that his enthusiasm needs to be modified by a careful discussion of the French data such as has already been done for Austria.

3. Suschnig, a general report for Austria. After a short sketch of the literature of the subject since 1750, in Austria, he gives a special description of the present state of affairs in the various provinces of Styria, lower Austria, Krain (Carniola), the Adriatic coast, Dalmatia, upper Austria, the Tyrol, and the Kaernten (Carinthia). In summarizing the results, he states that they have investigated thoroughly the efficiency of the cannon, and the altitude to which the vortex rings ascend, viz., three or four hundred meters. They have also begun a laborious investigation, as yet unfinished, into the laws of the movements of the vortex rings. He is endeavoring to respond to the general demand for accurate data as to the operations themselves. In general, every one is thoroughly satisfied with the results and no one doubts but that systematic shooting has accomplished good results.

4. Konkoly, for Hungary. The experience of the year has shown that the practical service leaves much to be desired, and the reporter, therefore, expresses the greatest reserve in judging of the value of the shooting.

5. Ottavi, for Piedmont, Italy. Although there were many hailstorms yet the stations were generally well protected, but there were three cases of severe extensive damage to the protected as well as the unprotected, namely, on May 17, June 12, and July 22. In many cases the shooting seems to be effective against hail, but in many others not so.

6. Alpe, for Lombardy. The shooting stations generally report good results, but cases of failure are believed to be the consequence of poor organization, feeble cannon or delay in shooting; nevertheless the severe misfortune at Mantua occurred in spite of perfect shooting and can not be excused.

7. Marescalchi, for Emilia.

8. Marconi, for Venice.

9. Bordiga, for southern Italy. These three reports were read by Ottavi and excited considerable discussion on account of their extreme conservatism.

10. Dufour, for Lausanne.

11. Salmones, for Spain.

In both of these countries the weather shooting has been tried only experimentally and to a small extent. It has excited lively interest but has contributed very little to our knowledge of the subject.

12. Gogol-Janoffsky, for Tiflis. This organization is quite recent; shooting was tried on 18 thunderstorm days with surprising results. In previous years the vines were injured more or less by hail four or five times annually, but this year not once. The same was also true throughout the Crimea, but nothing is stated as to whether hail fell on any fields outside of the regions of the protecting cannon.

13. Vidal, of Toulouse, reported on the use of rockets against hail clouds. He quoted 16 cases in which he had applied the rockets. Suschnig says "Although we think that the matter of the rockets has been settled, yet Professor Vidal deserves more attention than the congress gave him because of his service in other directions."

14. Andre, Director of the Observatory at St. Genis-Laval, spoke of the barometric conditions that prevail during a thunderstorm; the advent of a storm in general could be predicted several hours in advance by means of wireless telegraphy, as had been already done at his station and also in Rome.

15. Professor Porro, of the University at Genoa, advised a special service for thunderstorm predictions.

16. Gastine, delegate for the Minister of Agriculture for France reported on the vortex rings and the possibility of their action in hail shooting. He, with Vermorel, had made experiments in Villefranche similar to those made by Suschnig at St. Katharein, near Gratz, and concludes that in the present state of our knowledge of the meteorological processes going on in the clouds, it is impossible to give a definite opinion as to the value of the hail shooting, but that it is very desirable that continuous methodical observations should give us some explanation of the formation of thunderstorms and hail, for our errors and our doubts arise from our ignorance as to these phenomena.

17. Chardiny reported on the relation of weather shooting to the insurance associations, and recommended that the cannoneers be insured against accidents.

18. Deville, for the department of the Rhone, gave the statistics of hailstorms for twenty years, showing that they have done damage to the extent of \$1,000,000 annually. He demonstrated that the formation of hail is favored by the slope of the ground and that hail is less frequent in forest regions. He had already delivered a statistical memoir on this subject to the Academy of Sciences in Paris, stating therein that he could not conclude that the vortex rings had any efficiency against hail. He repeated that there is no demonstration of such efficiency, but that there are points upon which we may base a further earnest investigation of the subject.

19. Chatillon, for Villefranche.

20. Blanc, for Denicée, described the operations in their respective regions.

21. Chevallier spoke of the desirability of special legislation and that the regulations with reference to the protection from phylloxera should be extended to cover hail.

22. Picard, as manufacturer of explosives, reported that in France a quality of powder was used that responded perfectly to all demands.

23. Pistoij, major of artillery, reported on the technique of the shooting apparatus. He did not favor rockets and bombs.

24. Marangoni reported on the application of the shooting apparatus to the prevention of frost. Experiments on this subject had given no favorable results.

25. Plumandon delivered a general résumé, which is printed in full on page 35 of this REVIEW.

26. Professor Roberto explained his theory, based on careful observations, according to which hailstorms are simply powerful whirlwinds of air around a horizontal axis; the whirls can be broken up by the vortex rings from the cannon, but only the most powerful apparatus can be useful.

27. After a lively discussion, the congress finally adopted several resolutions, which may be summarized as follows:

A. That protection against hail demands the most earnest attention and study on the part of science.

B. That satisfactory results in hail shooting require the greatest possible extent of stations and uniformity of apparatus.

C. That it is important that the central meteorological stations should send to the local organizations for hail shooting earlier notices than now of the approach of thunderstorms, and furthermore that investigations by meteorological observatories into methods of protection against hail must be encouraged as much as possible.

D. The congress recommends the formation of a permanent international committee, whose problem it shall be to bring together all persons and societies interested in the subject; to publish the proceedings of this third congress, and to call together a fourth congress at the proper time. About twenty persons were appointed on this committee, including such eminent meteorologists as André, Plumandon, Pernter, Konkoly, and Dufour.

It was resolved that the thanks of the congress be expressed to all the governments who have taken an official part in it. An exhibit of apparatus was held during the session of the congress, but, in general, only smaller apparatus from French manufacturers were shown. The very extensive exhibit of Carl Greinitz and Nephews was assigned to the section on science and investigation, but unfortunately arrived too late to be examined by the jury of awards, which, indeed, did not visit this section at all. Certain members of the jury protested that, in the present experimental stage of the whole subject, it was not proper to make any classification of the various systems of shooting apparatus; that, in fact, none of those exhibited compared in efficiency with those made in Gratz, and that no diploma should be given except one of encouragement to all manufacturers alike.

Suschnig states that in the competitive trials in the presence of the jury, accidental explosions occurred necessitating the amputation of the right arm of the operator, and he adds that similar sacrifices have already become too numerous. In Venice and Lombardy alone there have thus far occurred five deaths and thirty severe accidents, so that the prefect of the Vicenza has forbidden any further shooting.

At the conclusion of the report Suschnig put on record the fact that about a month before the Congress at Lyons a National Italian Congress had been held at Novara, at which the Italian delegates to the Lyons Congress had been elected and had been instructed as follows:

The Novara Congress finds that the good results of hail shooting during the years 1899 and 1900 have only held good, for the season of 1901, in those places where the shooting has been conducted rationally and with sufficiently powerful apparatus and where thunderstorms of unusual severity have not occurred.

He gave also some details as to the reports relative to Novara by Professor Pochettino of Rome, Professor Rizzo of Perugia, Brucchiotti of Rome, Vicentini of Padua, all of which agree in showing that scientific questions as to the real efficiency and best methods of shooting must be decided by experts, and can not be profitably discussed in these general congresses. He concluded by saying that the Congress at Lyons made an excellent impression upon every one as to its sober consideration of the facts and arguments against the efficiency of hail shooting. There were no dramatic scenes and no trace of any effort to avoid scientific operations; there

was no disturbance as the meteorologists developed their views on the subject. Suschnig says: "it was as though recognition and thanks were due to science," and he adds, "It is to be hoped that the spirit which prevailed in this congress may also inspire future congresses on this subject."

It is indeed true that "recognition and thanks are due to science," for if it had not been for the strenuous demand on the part of scientists in Europe and America that this hail shooting delusion should be examined into carefully and treated from a common sense point of view, we might have beheld the Congress at Lyons promulgating a series of illogical and erroneous conclusions leading to a great waste of money and loss of life consequent upon the general adoption of the erroneous views that have spread so rapidly from Styria and Italy into southern France.

Errors, like ignorance, are always expensive. Science is only another word for truth and intelligent common sense. On account of the difficulties of scientific research it may cost \$100,000 to demonstrate some truth in nature, but when once attained such truths become the basis for an immense amount of saving in time, labor, money, and life. The sole object of the scientific world is to get at the laws of nature in order to serve the best interests of mankind. Of course this often mean iconoclasm as to old ideas and methods, but we who live on the earth, breathe its atmosphere and rejoice in its sunshine and cloud, can not afford to be ignorant of the laws of the material world around us. It would be a sad commentary on the civilization of France if the nation that has so greatly profited by accepting the wonderful results of the researches of Pasteur should make itself ridiculous by rejecting the equally important work of its famous meteorologists.—*C. A.*

#### GENERAL REPORT ON HAIL SHOOTING PRESENTED TO THE CONGRESS AT LYONS.

By Prof. J. R. PLUMANDON, Meteorologist of the Observatory of Puy-de-Dôme.

[Translated by Mrs. R. S. HOTZE.]

Allow me, in the first place, to express my regret that an unfortunate illness has deprived our congress of the valuable assistance of M. Houdaille, whom I have not the presumption to pretend to replace. In 1900 M. Houdaille was appointed by the minister of agriculture to make a series of studies in the wine regions of upper Italy, where the struggle against hail had already attained extraordinary development. In the course of his mission he collected numerous and important documents on all the points relating to this question, and particularly on the efficiency and the organization of the firing of cannon against hail clouds; he then summarized the publications on the subject which had been communicated to him, as well as his own personal observations, and issued, through his publisher, Alcan, a book filled with enlightened ideas and profound and accurate observations. Better than anyone else was M. Houdaille fitted (and he proved it in effect) to continue and bring to a happy conclusion the work that he had so well begun.

It was therefore not without much hesitation that I consented to accept the perilous honor of attempting to fill his place. I was induced to do so, first, by the extreme kindness of our president, M. Burelle, and of our general secretary, M. Silvestre, and, finally, I relied upon your indulgence, hoping that my twenty-five years of study of storms and hail would excuse my temerity.

Moreover, in the accomplishment of my task, which has already been facilitated by the eminent reporters who have preceded me, I shall have in view only an impartial search for truth, and I have already had the satisfaction of finding that

on all important points my opinions agree with those of M. Roberto, the learned supervisor of education of the Province of Alessandria, who is charged with a report similar to my own.

I have followed the reading of the reports with the greatest attention and have also studied them at length. I have purposely abstained from taking an active part in the discussion of these reports in order that I may consider them as a whole without any personal feeling and thus maintain the most absolute impartiality.

If we wish to judge of the results obtained against hail by the discharge of cannon, fusees, petards, or any other method which has for its object the combatting against storms, it is, of course, necessary to be acquainted with the experiments that have already been made. But it is none the less necessary to have in addition and above all, apart from all preconceived theories, rational ideas of the atmospheric conditions which produce hailstones. It is, moreover, almost indispensable, not only to have personally observed a great number of storms, but it is also and perhaps still more necessary to have studied them in their relations to the general conditions of the atmosphere. This implies the habitual use of the daily charts which show both the absolute and the relative values of the principal meteorological elements in their relation to thunderstorm phenomena. But be not alarmed, I am not going to theorize. In the question with which we are occupied you very rightly place facts above all else. I will invoke only these facts, and among them we shall find some that justify the struggle that you have entered upon against hail.

In the remarkable reports that have been communicated to us all the facts are interesting, but not all in the same degree, especially when it is desired to invoke them as proximate proofs of the efficacy of the firing of cannon to prevent the fall of hail. Let us take, for example, a case which has been frequently observed: In a locality well organized for defense, a storm approaches unexpectedly. By the blackness of the cloud, the darkness produced by it, the intensity of the lightning, and the continuous roll of thunder coming nearer and nearer it seems as though it must acquire extraordinary violence, and menace the region with disaster. The artillerymen are at their posts, and fire the cannon methodically. Soon the strength of the storm diminishes and it passes away, discharging over the region only a rain that is more beneficial than harmful.

Is it the firing of the cannon that has dissipated the storm? This is not absolutely impossible, but who can affirm that it is so, since dissipation occurs very frequently without any cannon at all being fired? It would be necessary to have a very large number of favorable observations in order to place any confidence in such a bold assertion. It is about the same with those assertions that attribute to the influence of the cannon shots various occurrences that may really be quite independent of it, such as the diminution of the violence or the frequency of the wind, of lightning, thunder, or hail, the dispersion or deflection of storm clouds, etc.

As proof positive of the influence of the firing on hailstorms the falls of snow observed in a certain number of localities during storms combatted by cannon have often been cited. It is said that the repeated discharges of the cannon transformed the hail into snow, or at least that they prevented the formation of hail and allowed only the formation of snow. Here again the proof is not sufficient, and these falls of snow are not necessarily the result of the firing, as they are also observed during storms against which no cannon have been fired. Moreover, they are of more frequent occurrence than is generally supposed, particularly in mountainous regions where they accompany a part of the storms of spring, autumn, and sometimes those of summer.

Snowstorms are of more frequent occurrence the higher we ascend in altitude, or the farther north we go in latitude, or